

Scope of Claim

[1] A method for water hammerless opening of a fluid passage characterized by that, with the method by which the fluid passage is made open by means of the actuator operating type valve provided on the fluid passage having the nearly constant pressure inside the pipe passage, first the valve body is moved toward the direction of the valve opening by the afore-mentioned driving input to the actuator being increased or reduced to the prescribed set value, and the driving input to the actuator is held at the afore-mentioned set value for a short period of time, and then, said driving input is further increased or reduced to make the valve in a state of full opening, thus the fluid passage being opened without water hammer.

[2] A method for water hammerless opening of a fluid passage as claimed in Claim 1 wherein it is so made that a normally closed and pneumatic pressure operating type diaphragm valve, or a normally closed and pneumatic operating type diaphragm valve which is of the fixed capacity type with the inner capacity of the valve not being changed when the valve is operated, is employed for a valve.

[3] A method for water hammerless opening of a fluid passage as claimed in Claim 1 wherein it is so made that the time for the driving input to the actuator being held at the set value for a short period of time is made to be less than 1 second, and the pressure rise value of the fluid passage is made to be within 10% of the pressure value before the valve is made open.

[4] A device for water hammerless opening of a fluid passage characterized

by that it is so constituted that it comprised a valve body, an actuator to drive the valve body, a vibration sensor removably fixed to the pipe passage on the upstream side of the valve, an electro-pneumatic conversion control device to which the valve opening/closing command signal is inputted and with which the actuator operating pressure Pa inputted to the actuator is controlled by the control signal Sc stored in the data storage part in advance, and a computation control device equipped with a comparison computation circuit to which the vibration detecting signal Pr from the afore-mentioned vibration sensor, the step pressure setting signal Ps to be supplied to the actuator, the step pressure holding time setting signal Ts , and the permissible upper limit vibration pressure setting signal Prm are inputted, and with which the afore-mentioned vibration detecting signal Pr and the permissible upper limit vibration pressure setting signal Prm are compared, and the afore-mentioned step pressure setting signal is adjusted, thus outputting the control signal Sc consisting of the afore-mentioned holding time setting signal Ts and adjusted step pressure setting signal Ps to the data storage part of the afore-mentioned electro-pneumatic conversion control device.

[5] A device for water hammerless opening of a fluid passage as claimed in Claim 4 wherein it is so constituted that a computation control device comprises a step pressure setting circuit, a holding time setting circuit, a permissible upper limit vibration pressure setting circuit, a vibration pressure detecting circuit and a comparison computation circuit; and when the vibration detecting signal Pr exceeds the permissible upper limit vibration pressure setting signal Prm

immediately after the actuator operating signal is step-changed, the step pressure setting signal P_s is adjusted toward the rising direction, and when the vibration detecting signal P_r exceeds the permissible upper limit vibration pressure setting signal P_{rm} immediately after the actuator operating pressure is made to zero from the intermediate step operating pressure, the step pressure setting signal P_s is adjusted toward the lowering direction.

[6] A device for water hammerless opening of a fluid passage as claimed in Claim 4 wherein it is so constituted that an electro-pneumatic conversion device comprises a data storage part which stores the control signal S_c from the computation control device, a signal conversion part and an electro-pneumatic conversion part, the actuator operating pressure control signal S_e is outputted from the signal conversion part to the electro-pneumatic conversion part based on the control signal S_c stored in the data storage part in advance with which no water hammer is caused.

[7] A device for water hammerless opening of a fluid passage wherein it is so constituted that it comprises an actuator operating type valve installed on the fluid passage, an electro-pneumatic conversion device to supply the 2-step actuator operating pressure P_a to the actuator operating type valve, a vibration sensor removably fixed to the pipe passage on the upstream side of the afore-mentioned actuator operating type valve, and a tuning box to which the vibration detecting signal P_r detected through the vibration sensor is inputted and from which the control signal S_c to control the step operating pressure P_s of the afore-mentioned 2-step actuator operating pressure P_a is outputted to the

electro-pneumatic conversion device, to output the 2-step actuator operating pressure Pa of the step operating pressure Ps' , which makes the vibration detecting signal Pr nearly zero, from the electro-pneumatic conversion device by adjusting said control signal Sc .

[8] A method for water hammerless opening of a fluid passage characterized by that, with the method for opening a fluid passage for which a vibration sensor is removably fixed on the upstream side of the actuator operating type valve installed on the fluid passage, and the vibration detecting signal Pr is inputted to the tuning box, and then, the control signal Sc from the tuning box is inputted to the electro-pneumatic conversion device, thus the 2-step actuator operating pressure Pa generated in the electro-pneumatic conversion device by the afore-mentioned control signal Sc being supplied to the actuator so that the actuator operating type valve is made open in the 2-step operation, the 2-step actuator operating pressure Pa to be supplied to the actuator and the vibration detecting signal are compared for the relative relation of the two, and if the vibration is generated at the time when the first step actuator operating pressure Pa rises, the step operating pressure Ps' is lowered, and if the vibration is generated at the time when the second step actuator operating pressure Pa rises, the step operating pressure Ps' is raised, and the step operating pressure Ps' of the step operating pressure Pa to make said vibration detecting signal Pr nearly zero is determined by repeating a plural number of adjustments of raising or lowering the afore-mentioned step operating pressure Ps' so that the afore-mentioned actuator operating type valve is made

open based on the data on the control signal Sc when the 2-step operating pressure Pa of the step operating pressure Ps' to make the generation of said vibration nearly zero is outputted from the electro-pneumatic conversion device.

[9] A method for water hammerless opening of a fluid passage characterized by that, with the method for opening a fluid passage for which a vibration sensor is removably fixed on the upstream side of the actuator operating type valve installed on the fluid passage, and the vibration detecting signal Pr is inputted to the tuning box, and then, the control signal Sc from the tuning box is inputted to the electro-pneumatic conversion device, thus the 2-step actuator operating pressure Pr generated in the electro-pneumatic conversion device by the afore-mentioned control signal Sc being supplied to the actuator so that the actuator operating valve is made open in the 2-step operation, the 2-step actuator operating pressure Pa to be supplied to the actuator and the vibration detecting signal Pr are compared for the relative relation of the two, and if the vibration is generated at the time when the first step actuator operating pressure Pa drops, the step operating pressure Ps' is raised, and if the vibration is generated at the time when the second step actuator operating pressure Pa drops, the step operating pressure Ps' is lowered, and the step operating pressure Ps' of the 2-step operating pressure Pa to make said vibration detecting signal Pr nearly zero is determined by repeating a plural number of adjustments of raising or lowering the afore-mentioned step operating pressure Ps' so that the afore-mentioned actuator operating type valve is made open based on the data on the control signal Sc when the 2-step operating

pressure Pa of the step operating pressure Ps' to make the generation of said vibration nearly zero is outputted from the electro-pneumatic conversion device.

[10] A method for water hammerless opening of a fluid passage as claimed in Claim 8 or Claim 9 wherein it is so made that the vibration sensor and tuning box can be removed after the data on the control signal Sc at the time of outputting the 2-step operating pressure Pa with which the generation of vibration is nearly zero were inputted to the memory storage of the electro-pneumatic conversion device.

[11] A method for water hammerless opening of a fluid passage as claimed in Claim 8 or Claim 9 wherein it is so made that the vibration sensor is provided at the position on the upstream side within 1000mm from the place where the actuator operating type valve is installed.

[12] A method for water hammerless opening of a fluid passage as claimed in Claim 8 or Claim 9 wherein it is so made that the step operating pressure holding time t of the 2-step operating pressure Pa is set at less than 1 second.

[13] A method for supplying a chemical solution wherein it is so made that with which a fluid is supplied to the fluid passage on the downstream side by opening the fluid passage by means of the actuator operating type valve installed on the fluid passage having a nearly constant internal pressure therein, a chemical solution is used for a fluid, and firstly, the valve body is moved toward the direction of the valve opening by increasing or decreasing the afore-mentioned driving input to the actuator to the prescribed set value, and the actuator driving input is held at the afore-mentioned set value for a short period

of time, and then, said driving input is further increased or decreased to make a valve in a state of full opening so that water hammer does not occur at the time of the valve being opened.